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DOLORES ARCHAEOLOGICAL PROGRAM TECHNICAL REPORTS

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Archaeomagnetic Sampling Program

by

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techniques, the results of temporal analysis of program sites can be used to verify the existing archaeomagnetic calibration curve.

Archaeomagnetic dating is a technique which enables archaeologists to independently assess temporal estimates of burned prehistoric contexts. The standard error associated with archaeomagnetic dates is usually about ± 40 years in the southwestern U.S. (Eighmy et al. [1:514]), with error estimates ranging from ± 20 to ± 60 years depending on the associated reliability of the sample. The reliability of the data is dependent on a number of factors, including the number of collected specimens per sample, technical accuracy when collecting specimens, and the degree of uncertainty in the point of particle orientation or the secular variation curve. (This last is the plotted path which traces the fluctuation of the geomagnetic pole over the northern polar area. There are sections of this path which double back on or cross over previous geomagnetic plottings, making it difficult to make an exact determination of dates within these ambiguous areas.)

Training and Initiation

To begin the D.A.P. archaeomagnetic sampling program, field-training sessions directed by Dr. J.L. Eighmy of Colorado State University, Fort Collins, were held on 2, 3, and 4 September 1978. These sessions were attended by four D.A.P. staff members; each person received from 8 to 20 hours of intensive training. A fifth staff member was later added to the archaeomagnetic program and was given training in methods by the Special Studies Crew leader after the initiation of the program.

These training sessions consisted of procedural rehearsals in collecting samples from various prehistoric in situ features,

participatory discussions on topics relating to the removal of samples, and a presentation of the basic theory behind archaeomagnetic dating (this last topic included how and why fire-hardened features can be dated and the basic procedures involved in laboratory analysis). The archaeomagnetic-sampling-program personnel were also required to become familiar with a procedural text, "Archaeomagnetic Sampling--A Procedural Primer" (Rodgers [2]). The methods presented in this text were adopted for the extraction of D.A.P. samples.

On 25 September 1978, the D.A.P. Special Studies Crew was organized, with archaeomagnetic sampling as one of their primary tasks. Archaeomagnetic samples were collected at a total of six prehistoric sites in the program area, all of which had been excavated by D.A.P. field crews during the summer and fall. Archaeomagnetic sampling field operations were conducted on 29 days between 2 September and 16 November, by crews consisting of one to two technicians. A total of 37 samples was collected during this time span. All archaeomagnetic samples were evaluated, extracted, processed, and transported (with adequate supporting information) to the Colorado State University Laboratory. Crew members were K. Bauman, J. Keidon, and L. Maness.

METHODOLOGY

Archaeomagnetic dating is classified as a chronometric technique and is used to date the most recent period of firing in hearths, in structural remains, etc. According to Michels [3:130]:

> Archaeomagnetic dating is based on the known fact that the direction and intensity of the earth's magnetic field vary over the years. Clay and clay soils contain magnetic minerals, and when the clay is heated to a certain temperature, these minerals will assume the direction and a proportional intensity of the magnetic field which surrounds them. They will retain this direction and intensity after they are cooled. By measuring these quantities, the age of the sample can be determined if the changes in the earth's magnetic field at that location are known.

Clay or clay soils in archaeological context acquire a weak permanent magnetism when heated to a dull-red heat and allowed to cool (Michels [3]). This heating is commonly the result of domestic cooking or firing in a hearth or oven or, less commonly, of a conflagration in a room or pitstructure. As the temperature in the clay is raised, the magnetic particles with ferromagnetic behavior (such as magnetite and hematite) found naturally in some soils are aligned by the earth's magnetic field; on cooling, the particles remain fixed in that orientation. The saturation magnetization is dependent on the Curie temperature of the ferromagnetic minerals present, the temperature attained during firing, and the homogeniety of heating throughout the matrix. The remanent magnetization acquired can be altered in several ways. Viscious remanent magnetization (VRM) is the tendency of 'soft' magnetic particles to follow weak ambient fields and is related to time. Chemical remanent magnetization (CRM) occurs as small ferromagnetic minerals grow to an appropriate size or as one magnetic mineral is altered to another (i.e., oxidation of magnetite to hematite). Isothermal remanent magnetization (IRM) occurs in

the presence of a strong magnetic field (such as lightening) and can induce a magnetization (parallel to the field lines of external field) on the ferromagnetic minerals. These three sources can often be detected and the affects removed by various laboratory treatments. Finally, physical displacement of the magnetized matrix will irreparably alter the remanent direction of the prehistoric orientation.

It is possible to obtain a chronometric date for an archaeomagnetic sample only if the secular variation curve has been established for the region in question. The position of the geomagnetic north pole is known to vary temporally according to fluctuations in the main field of the earth and to regional disturbances. If the path of the pole as it oscillates through time has been mapped, usually by cross-dating with another established dating technique such as dendrochronology, then it is possible to apply archaeomagnetic dating in that area.

DuBois has pioneered the effort to establish a secular variation curve for the American Southwest (Watanabe and DuBois [4], Weaver [5], DuBois [6]). For this calibration, he has collected archaeomagnetic samples from many prehistoric sites and analyzed them using cross-dating from C-14 and dendrochronological analyses of beams and other structural wood recovered from the same sites. Researchers Eighmy, Steinberg, and Butler [1] and Wolfman [7] have recently reported arhcaeomagnetic results from New Mexico, Arizona, and Arkansas verifying the latter portion of the Southwest curve (A.D. 1000-1500).

A different technique of archaeomagnetic dating is palaeointensity (Michels [3:142]). This method currently is in an experimental stage, although it may have future bearing on dating in southwestern archaeology (J. Eighmy, personal communication). Palaeointensity dating is

potentially valuable in that it can be applied to disturbed ceramic items, such as pottery vessels and figurines, in prehistoric contexts. This is possible because unlike directional archaeomagnetic dating, which requires determination of in situ particle orientation, archaeomagnetic intensity dating requires knowledge only of the intensity of the magnetic field at the time of firing (Michels [3]). Palaeointensity analysis has different capabilities and limitations and different sources of error; research and development of this technique has lagged significantly behind directional archaeomagnetism, and it is not yet usable as a dating technique in the southwest.

FIELD PROCEDURES

Evaluation

The initial step in collecting archaeomagnetic samples is the evaluation of the feature which is to be dated to determine the potential for obtaining a sample suitable for analysis. Several factors are important in this determination; these are discussed below.

Firing Environment

Optimum firing for dating purposes occurs in an oxidizing atmosphere (a situation in which the firing atmosphere receives an excess amount of oxygen) which normally turns the soil a red-orange color and makes it easy to differentiate from surrounding soils. Reduced firings (firing with a deficiency of oxygen) generally turn the affected soils a gray-black color; they are somewhat more difficult to differentiate from surrounding soils (particularly if an ashy fill is present) but are usually sufficient for dating purposes.

Setting

An in situ situation is essential for archaeomagnetic dating, and the setting of the feature to be sampled should be carefully evaluated and discussed with the site supervisor. Any remarks concerning setting should be included in the firing-quality comments on the Archaeomagnetic Sample Data Form as this will aid in the determination of the reliability of the sample. It is possible to obtain a datable sample from features such as clay remnants of fallen roof-burn materials, provided that the cooling process took place in the location where it was archaeologically recorded.

Size

The size of the sample area must also be considered. It may be impossible to collect the desired minimum number of specimens from a small burned area, thereby decreasing sample reliability. The minimum number of specimens that will yield a reliable date is eight; removal of each specimen requires approximately 5 cm^3 of working space.

Coordination

Archaeological recording of the area to be sampled must be completed before extracting procedures can commence; that is, all photography, mapping, and recording of other pertinent information must be completed. Extraction of archaeomagnetic samples destroys the feature and tends to litter the surrounding area.

Preparation

When a feature has been determined to be a feasible location for archaeomagnetic sampling, it should be prepared for removal of specimens. This often entails soaking the feature overnight with water if the soil is especially hard packed. It is believed that this technique does not alter the prehistoric magnetic orientation; the effects of time and weathering have produced a much greater disturbance of the matrix with few undesirable affects, and archaeomagnetic samples from wetted matrices show no tendency towards magnetic displacement or larger reliability factors. Occasionally samples may be cut from a dry matrix, but the soil types common in the project area require most of the samples to be extracted from a moist medium.

Different types of features require different techniques in preparation; these are discussed below.

Burned Adobe or Clay Walls

Correct procedure for preparation of a fire-hardened clay or adobe wall is to clear an area approximately .50 m wide by 1 m long on the exterior surface of the wall, preferably where the greatest amount of oxidation has occurred. It may be necessary to construct an earth berm from the floor up to the sample area to facilitate the extraction of the sample. The berm aids in steadying the mold and produces a seal to ensure that the wet plaster does not leak from the bottom of the mold.

Slab-lined Features

To prepare a slab-lined feature it may be necessary to carefully remove the slabs (preferably after the feature has been soaked) and collect the specimens from the cracks between the slabs, as these areas are optimal for analysis.

Unlined Hearths and Floors

Unlined hearths or clay-baked floors may require overnight soaking to produce a medium conducive to removal of specimens. Other features may require different modifications for preparation; this is dependent on the discretion of the technician.

Extraction

Before the actual carving and extraction of the sample specimens, the placement of all 12 specimens (the optimum number for a reliable sample) (Eighmy [9:31]) should be well thought out to obtain a maximum of good, oxidized specimens within a minimum space. Because very few prehistoric hearths probably reached the Curie point of the magnetic minerals a total thermoremanent magnetization was probably not being acquired by these matrices, but rather a partial thermoremanent

magnetization was acquired. Remanent magnetization is not acquired linearly (Irving [8:27]) but ideally is mostly acquired within 100° C of the Curie temperature. The law of additivity for partial TRM (Nagata [10:160]) states that the remanence acquired at each temperature interval equals the total TRM acquired. Therefore the optimum sample locations within a feature are areas containing clay matrices which were in contact with the hottest part of the fire; these areas would have been subject to the highest temperature and hence contain the greatest degree of thermoremanent magnetization. Areas with excessive organic material or a pebbly matrix should be avoided if possible, as these types of foreign matter tend to interfere with accurate analysis (e.g., the sides and lip of an adobe or clay hearth will generally be the best place to sample, as the bottom has a greater amount of organic material).

Once the sampling area has been prepared and a basic plan of the specimen placement is conceived, the actual sampling process begins (Figure 12.1). This process is summarized below.

Carving Specimens

A minimum of 8 specimens is necessary for reliable analysis, and 12 specimens is optimum. Cut specimens measure approximately 1 by 1 by 1.5 cm, and a total area of 5 cm^3 is necessary to extract each specimen. It is essential during the extraction process that the specimens are not bumped or disturbed in any way, so that the orientation of the specimen, and thus the prehistoric thermoremanent orientation, is preserved.

Molding

The mold consists of an aluminum cube casing which measures 4 cm^2. (Dimensions can vary; the size mentioned was found appropriate for the

Figure 12.1 Beginning the process of collecting an archaeomagnetic sample.

purposes of the Dolores Archaeological Program.)

When the specimen has been carved, the cubes are prepared by oiling the interior of the aluminum casing and setting a one-quarter in diameter modeling-clay buffer around the bottom. Oiling allows the plaster to release easily from the mold, and the clay buffer forms a cushion to assist in leveling and sealing the mold. The casing is then placed over the specimen and leveled (with a cross-test level).

Plastering

Hydrocal white plaster is mixed with water to a cream-like consistency and poured into the mold, surrounding the specimen on five sides (all but the bottom).

Orientation and Recording

Declination is recorded from the east side of the mold with a Brunton compass (accurate to one-half degree; Eighmy [9:63]), and the specimen is allowed to partially dry. The cube is scraped smooth across the top and engraved with a stylus; the legend contains the sample and specimen number and an arc indicating the corner of declination (normally the southeast corner).

Removal from Sample Area

Before removal of the specimen, its location is diagrammed on a schematic map of the feature, indicating the area sampled. The specimen is then removed from the sample area. The bottom of the specimen is trimmed so that the cube is recessed one-eighth in into the mold. This depression is then filled with plaster, allowed to dry, and scraped smooth.

Removal from Mold

Each corner of the mold is secured with brass screws which can be

removed to release the plaster-encased specimen. The specimen is then removed to a safe location and allowed to set, a process that takes approximately three days.

Storage and Analysis

After setting, the samples are wrapped, catalogued, and sent to the Colorado State University Anthropological Laboratory for analysis and dating of the feature.

RESULTS OF THE 1978 ARCHAEOMAGNETIC SAMPLING PROGRAM

Archaeomagnetic samples were collected on sites excavated during the 1978 D.A.P. field season from all fire-hardened features judged by a preliminary evaluation to be adequate for analysis. The analyses of these samples should yield information on the temporal placement, occupational span, and intra-site relationships of major structural features and of minor features within the sites recently investigated. A site-specific description of archaeomagnetic operations conducted during the 1978 field season is presented below. Appendix A contains a site-by-site summary of samples.

Site 5MT2151 (LeMoc Shelter)

Site 5MT2151 is located in a south-facing rock shelter on the north slope of the Dolores River canyon. The site is located in the Grass Mesa Archaeological Locality and probably was occupied continuously by prehistoric populations on a temporary or permanent basis for at least 400 to 500 years (A.D. 600-1050). The site is stratigraphically complex; during the earliest documented use of the shelter in the Basketmaker III and Early Pueblo I periods (approximately A.D. 600-800), the site was a small hamlet with one to two households. (The shelter might have been occupied earlier by Archaic populations; however, to date there is no evidence of any use before the Anasazi Tradition.) Later, during the Late Pueblo I and Pueblo II periods (approximately A.D. 800-1050), the site was used as a seasonal camp and processing area. Archaeomagnetic sampling at LeMoc was directed toward temporally documenting the features associated with these different use periods. A total of 10 samples was recovered from Site 5MT2151; most

features sampled during the 1978 season apparently are associated with the later Pueblo I and Pueblo II seasonal occupations.

The Archaeomagnetic Samples

Three samples were collected from hearths built on cultural fill in the western half of the shelter. The hearths are associated with Pueblo II ceramics and were probably used in the time span A.D. 950-1050; however, there is a possibiity that the hearths were also used by modern visitors in the period A.D. 1900-1950. The matrices from which the samples were removed were coarse and granular and the fires in the hearths were low-temperature in nature. Hence, these samples were taken from inferior recovery situations and are expected to have a large standard deviation.

Three samples were collected from hearths located in the fill of Pitstructure 1 in the eastern half of the shelter. These features were obviously utilized after the abandonment of the pitstructure (a Pueblo I pithouse) and are associated with Pueblo I and Pueblo II ceramics. It seems likely that the hearths date from about A.D. 850-950 (the McPhee Phase). Again, the samples were collected from questionable matrices, and a relatively large standard error is expected.

One sample was collected from the central hearth of Pitstructure 1. This structure is a fairly typical semi-rectangular Pueblo I pithouse with a fairly distinct roof-post pattern and floor-level ventilator; one tree-ring date from a roof timber indicates that the structure was built in the first half of the ninth century A.D. Therefore, it is expected that this archaeomagnetic sample will yield a date of about A.D. 825-850.

Two samples were collected from fire-hardened floor surfaces located in the roomblock to the rear (north) of the shelter. These rooms were

probably constructed during the Sagehen Phase sedentary occupation of the site (A.D. 650-850) but have probably seen much subsequent utilization. Due to the nature and extent of the burned area, one sample is thought to represent a modern fire. The other sample should allow a temporal placement of the last prehistoric use of the roomblock area, perhaps around A.D. 1050.

One sample was recovered from the bottom of a fire-hardened cist in the western half of the shelter. This feature was probably utilized during the Sundial Phase occupation, as were other features in an upper stratigraphic context in this part of the cave; a date of about A.D. 950-1050 is expected. The collecting matrix for this sample was in excellent condition, and a low sampling error is expected.

Summary

Archaeomagnetic samples recovered from LeMoc Shelter during 1978 were collected primarily from small features (hearths and cists) representing the McPhee Phase seasonal occupation of the site. Most of the sample matrices from which the collection was taken were far from ideal, and relatively large standard errors are expected. The 1978 collection from Site 5MT2151 should be adequate to sequence these many temporary occupations and to date the last period of use of Pithouse 1. In 1979, archaeomagnetic sampling operations at LeMoc will focus on determining the temporal placement and stratigraphic sequence in Pitstructure 2, a pithouse located beneath the McPhee Phase temporary-use areas in the western part of the site.

Site 5MT2191 (Little House)

Site 5MT2191 is a small surface site located in the Sagehen Flats

Locality approximately 2 km west of the Dolores River. The site probably functioned as a field house during the McPhee Phase (approximately A.D. 850-900). The site is situated 1.7 km southwest of the contemporaneous McPhee Village and might have been utilized by family groups living at this larger habitation. Architectural remains at the site consist of a small roomblock containing four jacal rooms and an activity area to the south containing several hearths and cists (for a more detailed presentation of Site 5MT2191 see Hewitt [11]). Two archaeomagnetic samples were collected from this site, one from a hearth in Room 1, the front room of the roomblock, and the other from a hearth in the activity area south of the roomblock. Both samples should temporally place the last use of both hearths, and probably the last use of the site as well. An analysis of the ceramic collection recovered from the site indicates that it was probably abandoned around A.D. 900.

Site 5MT2193 (Dos Casas Hamlet)

Site 5MT2193 is a small habitation in the Sagehen Flats area located about 3 km west of the Dolores River. This site is in the Sagehen Archaelogical Locality and functioned as a small permanent habitation or hamlet. Major architectural remains investigated at the site include a crescent-shaped roomblock of five to six south-facing jacal rooms and two pitstructures in an outside use area to the south of the roomblock. The two pitstructures are not contemporaneous; Pithouse 2 was built after Pithouse 1 had burned and is located about 10 m closer to the roomblock. Tree-ring analysis conducted on samples recovered from the pitstructures indicates that Pithouse 1 was constructed approximately A.D. 760 and Pithouse 2 approximately A.D. 770. The site was probably occupied

by a single family and can be assigned temporally to the Sagehen Phase; Site 5MT2193 was probably occupied during the time span A.D. 750-800. (For a more detailed description of Site 5MT2193, see Brisbin [12]).

During 1978, six archaeomagnetic samples were collected from the roomblock area of the site, three from hearths and three from fire-hardened floor areas. The samples will be used to temporally place the last prehistoric use of the hearths and the time of a large conflagration which apparently swept the entire roomblock; this latter was the agent responsible for the fire-hardened floor areas. It is expected that the dates for both the hearths and the floors will be in the range A.D. 780-800. Again, some of the samples collected from this site were from poor matrices, so a large standard error in these cases is anticipated.

Continued investigations at Site 5MT2193 are scheduled for the 1979 field season and include additional collection of archaeomagnetic samples. Samples will be collected from the central hearths of Pithouses 1 and 2, from burned areas on the walls of the pitstructures (both Pithouses 1 and 2 were subject to intense conflagrations during the prehistoric period), and from any additional suitable burned features (hearths, ovens, etc.) encountered during the course of the excavation.

Site 5MT2198 (Sagehill Hamlet)

Site 5MT2198 is a small hamlet located in the Sagehen Flats area 3.5 km west of the Dolores River. The site was probably occupied by a single nuclear or extended family during the Sagehen Phase. Major architectural remains investigated at the site include a pithouse and

ancillary use and storage areas to the north and east (for a more detailed discussion of Site 5MT2198, see Hewitt [13]).

Two archaeomagnetic samples were recovered from the site, one from the central hearth of the pithouse and the other from a hearth located to the southeast of this structure. The sample collected from the pithouse should temporally place the last use of this feature; tree-ring data recovered from the site indicates this placement should be in the time range A.D. 660-680. The sample from the earth to the southeast of the main house will temporally place the last prehistoric usage of this feature; the time range expected is similar to that for the sample collected from the pitstructure. A large standard error is expected with the calibration of this latter sample due to the poor quality of the collection matrix.

Site 5MT2235 (Marshview Hamlet)

Site 5MT2235 is a small surface site located in the Sagehen Flats area 1.8 km west of the Dolores River. The site is in the Sagehen Archaeological Locality, is a small permanent or seasonal habitation, and was probably occupied by one Anasazi family. The site is an anomaly in the area due to its apparent late occupation; preliminary analysis of the ceramic collection and tree-ring dates indicates that the site was occupied in the first half of the twelfth century A.D., thus placing it within the time span of the Sundial Phase. Architectural remains investigated at the site include a small pitstructure and several exterior ancillary features (for a detailed report of this site, see Bussard [14]).

Few archaeomagnetic samples were collected from the site during the 1978 field season. One sample was recovered from the central hearth of the kiva and should temporally place the last prehistoric use of this feature; the dendrochronological data indicate that the last usage was in the time span A.D. 1110-1130. The placement of the other three samples is more problematical; all were collected from hearths, two apparently located on the prehistoric ground surface (probably within outside activity areas associated with the single kiva) and the other located in post-abandonment fill layers within the kiva. This last sample obviously postdates the main occupation of the site and probably represents a seasonal use of the site area. The two surface hearths might have been utilized by the users of the kiva, by later peoples using the site area as a temporary camp, or by both. In either case, archaeomagnetic analysis of these samples should temporally place the last prehistoric usages of Site 5MT2235 at perhaps approximately A.D. 1125-1150.

Site 5MT4475 (McPhee Pueblo)

Site 5MT4475 is a large multi-component habitation possibly incorporating inter-site integrative architecture and functions. The site is located in the Sagehen Archaeological Locality and is classed as part of a larger village in the typological system developed by D.A.P. personnel; during the McPhee Phase this habitation and other large villages (Cline Crest Pueblo, House Creek Pueblo, etc.) in the Escalante Sector might have formed the first tier of a central-place-type settlement pattern. The site is situated on an alluvial terrace on the west side of the Dolores valley and is about 500 m from the river in its present course. The architectural remains at the site consist of a very large

horseshoe-shaped roomblock (probably 35 or more rooms) facing the southeast, an open area enclosed by the horseshoe containing organized outside activity areas and pitstructures, and a large trash midden to the south of the domicile area (for a description of investigations at McPhee Pueblo during 1978, see Brisbin [15]). Thirteen archaeomagnetic samples were collected from Site 5MT4475; both the roomblock area and pitstructure are represented in the collection.

The Archaeomagnetic Samples

Five samples were recovered from Pitstructures 1-3 (superimposed structures in the same horizontal location) located in the plaza area inside the horseshoe. Two of these samples were collected from Pitstructure 1 (an early Pueblo II masonry-lined kiva), one from the central hearth and the other from a burned area on the north wall. The samples should temporally place the last use and abandonment of the kiva; ceramic and stratigraphic evidence indicates this placement will be in the time span A.D. 940-970.

One sample was collected from Pitstructure 2, an early earth-lined kiva below Pitstructure 1; the sample was taken from a burned floor area in the northeast quarter of the structure. The sample should temporally place the last usage of Pitstructure 2; stratigraphic interpretation of the depositional sequence indicates this was in the time span approximately A.D. 910-940.

Two samples were recovered from matrices associated with Pitstructure 3, a Pueblo I semi-rectangular pithouse located below Pitstructures 1 and 2. One of these samples was recovered from a burned area on the south wall of the structure and the other from fallen floor-burn material behind the west wall of Pitstructure 2; this latter is asssumed to represent the

fallen roof of Pitstructure 3. These two samples should date the last usage of Pitstructure 3; stratigraphic interpretations indicate this placement will be in the time span A.D. 890-910.

Seven samples were recovered from hearths in the roomblock and courtyard area (Rooms 1, 7, 8, and 10, and Courtyard 1) in a context representing the late McPhee Phase occupation. These samples should temporally place the last usage of the roomblock; preliminary analyses of the ceramic assemblage and stratigraphic sequence at the site indicate this placement will be in the time span A.D. 940-910.

One sample was recovered from a hearth on a lower floor in Room 7; the floor apparently represents the early McPhee Phase occupation at the site. The sample should date the last occupation of these lower floors approximately A.D. 890-910, according to an interpretation of stratigraphic and ceramic evidence.

Summary

Samples collected from McPhee Pueblo during the 1978 season were recovered from rooms located in the bend of the horseshoe and from pitstructures in the interior plaza area; the samples represent the McPhee Phase occupation at the site. In general, the collecting matrices were of superior quality for recovery purposes, and relatively small standard errors are expected. Further investigations at McPhee Pueblo are planned for the 1980 field season; archaeomagnetic sampling operations during that period will be directed toward refining the tentative chronological sequence at the site and temporally placing earlier occupations.

A site-specific listing of the archaeomagnetic samples collected during the 1978 season with their proveniences and approximate dates is presented in Appendix A.

SUMMARY AND CONCLUSIONS

A total of 37 archaeomagnetic samples were collected from 6 prehistoric sites during the Dolores Archaeological Program 1978 field season; actual labor expenditures involved in the field portion of the collecting program amounted to 58 person-days. The sampling progam is expected to yield a wide range of dates, probably from A.D. 670-1150, reflecting the long sequence of occupation in the first-year study area. The range is within the current calibrated time span for archaeomagnetic dating in the American Southwest, which is from A.D. 600-1500. All Anasazi phases identified in the first-year area of operations are represented in the sample collection; however, samples representative of the Great Cut Phase (the local Archaic manifestation, approximately 5000 B.C.-A.D. 500) and the Beaver Point Phase (the local proto-historic occupation, approximately A.D. 1400-1900) are lacking, as no suitable features dating to these cultural periods were excavated during the 1978 season.

Very few mechanical or procedural problems were encountered during field operations of the program. Some scheduling difficulties did take place due to problems in assessing collecting priorities; toward the end of the season, inclement weather and damp collecting conditions also resulted in unforeseen delays. Because the field season was abruptly terminated in late November (again, due to the weather), archaeomagnetic sampling was not completed at one site, Site 5MT2193; completion of operations at this location will be given first priority during 1979.

To date, laboratory analysis of the collection has not been completed. There have been several problems with equipment and analytical

procedures at the Archaeomagnetic Dating Laboratory at Colorado State University. Presently, these problems appear to be at least partially solved. The remainder of the analyses should be completed by the start of the 1979 field season. Appendix A contains an interim report from Dr. J. Eighmy of Colorado State University.

It is anticipated that the results of the year one archaeomagnetic sampling program (when augmented by dendrochronological data) will provide a comprehensive base for evaluating the occupational sequences in the sites and localities investigated. All Anasazi cultural phases tentatively identified are well represented in the collection; a minimum of two samples was collected from all sites excavated during 1978, with one exception (the exception, Site 5MT2202, had no suitable features). The first-year collection, when calibrated with results of dendrochronological analysis and ceramic seriation, should provide excellent data for testing the validity of the accepted Master Polar Curve.

An expanded D.A.P. archaeomagnetic sampling program is scheduled for 1979, with an anticipated collection of 100 samples.

The priorities and goals of the 1979 program are as follows:

1. complete sample recovery at sites begun during the 1978 season (Site 5MT2151 and Site 5MT2193)

2. employ the sampling program to achieve fine temporal controls at two larger, stratigraphically complex sites scheduled for intensive investigation in 1979 (Grass Mesa Village, Site 5MT0023, and House Creek Village, Site 5MT2520)

3. employ the sampling program to assist in dating other, smaller sites scheduled for excavation in 1979

4. augment the sample collection to aid in testing and extending the Master Polar Curve. (The potential exists in the program area to extend the curve in the direction of the A.D. 600 limit, perhaps to A.D. 400-500).

APPENDIX A

SITE-BY-SITE SUMMARY OF ARCHAEOMAGNETIC SAMPLES
1978 FIELD SEASON

Site 5MT2151 (LeMoc Shelter)

Sample #	Provenience	Cultural Context	Archaeological Guess Date (A.D.)	Sample Quality and Comments
1	Sq 8E19, Str 3 Fea 26	Temp. hearth Sundial Phase	1000 ±20	Good sample, some organic inclusion, good oxidation
2	Room 10, Str 1	Fire-hardened floor, McPhee Phase	875 ±25	Good sample, good oxidized surface, but very shallow
3	Sq 8E13, Occ Area 4, Str 2, Fea 28	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Poor sample, high organic inclusion, poor matrix
4	Sq 8E11, Occ Area 3, Str 5, Fea 29	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Poor sample, high organic inclusion, poor matrix
5	Sqs 7E14, 7E15, 8E14, 8E15, Occ Area 1, Subarea 3, Fea 25	Fire-hardened cist McPhee Phase	950 ±50	Good oxidation, high organic inclusion, poor matrix
6	Sq 8E11, Occ Area 3, Str 5, Fea 29	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Good sample, high organic inclusion
7	Sq 9E20, Str 2, Fea 24	Temp. hearth McPhee Phase	1000 ±50	Good sample, very little organic inclusion, good matrix
8	Sqs 8E21, 9E21, PS 1, Subarea 3, Str 4, Fea 38	Temp. hearth McPhee Phase	950 ±50	Good oxidation, high organic inclusion, poor matrix
9	Rm 1, Sur 1	Fire-hardened floor McPhee Phase or recent	950 ±50 1900 ±50	Good oxidation, very little organic inclusion, fair matrix
10	PS 1, Floor 1, Occ sur 1, Fea 46	Central hearth Sagehen Phase	815 ±50	Good sample, fair oxidation, excellent matrix

Site 5MT2191 (Little House)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Exterior work area, Fea 11	Slab-lined hearth Sagehen Phase	A.D. 850 ±50	Fair sample, some organic inclusion, fair matrix
2	Rm 1, Floor 1, Fea 6	Hearth Sagehen Phase	A.D. 850 ±50	Good sample, very little organic inclusion, fair matrix

Site 5MT2193 (Dos Casas Hamlet)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Rm 2, Sub. 4, Sur 2, Fea 16	Temp. hearth Sagehen Phase	A.D. 775 ±25	Good sample, moderate organic inclusion, fair matrix
2	Rm 1, Sub. 4, Sur 1	Fire-hardened floor Sagehen Phase	A.D. 775 ±25	Fair sample, fair oxidation, poor matrix
3	Rm 3, Sur 2	Fire-hardened floor Sagehen Phase	A.D. 775 ±25	Very poor sample, high organic inclusion, poor matrix
4	Rm 5, Str 2, SE Quad, Fea 11	Slab-lined hearth Sagehen Phase	A.D. 775 ±25	Very good sample, some organic inclusion, good oxidation
5	Rm 1, Sur 1	Fire-hardened floor/possible roof fall Sagehen Phase	A.D. 775 ±25	Fair sample, excessive organic inclusion, good oxidation
6	Sq 120S/184E Fea 7	Hearth Sagehen Phase	A.D. 775 ±25	Good sample, some organic inclusion, good matrix

Site 2198 (Sagehill Hamlet)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Sqs 034032 and 036032, Level 1, Fea 2	Slab-lined hearth Sagehen Phase	A.D. 700 ±20	Good sample, moderate organic inclusion, good matrix
2	PS 1, Sur 1, Fea 8	Central hearth Sagehen Phase	A.D. 680 ±30	Very good sample, very little organic inclusion, good matrix

Site 5MT2235 (Marshview Hamlet)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Test tr 6, Level 2, Fea 8	Temp. hearth Sundial Phase	A.D. 1100 ±50	Fair sample, moderate organic inclusion, fair oxidation
2	Sq 016014, Level 2, Fea 10	Temp. hearth Sundial Phase	A.D. 1100 ±50	Fair sample, moderate organic inclusion, fair oxidation
3	PS 1, Str 2, Fea 10	Temp. hearth Sundial Phase	A.D. 1120 ±30	Good sample, high organic inclusion, good oxidation, fair matrix
4	PS 1, Sq 010014, Floor 1, Fea 11	Central hearth Sundial Phase	A.D. 1080 ±30	Excellent sample, very little organic inclusion, good oxidation, good matrix

Site 5MT4457 (McPhee Pueblo) (Page 1 of 2)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Pueblo A, PS 1, Sur 2, Fea 24	Central hearth Late McPhee Phase	A.D. 940 ±20	Good sample, charcoal inclusion, good oxidation
2	Pueblo A, PS 2	Fire-hardened wall, McPhee Phase	A.D. 910 ±20	Good oxidized area, but area appears disturbed, fair-poor sample
3	Pueblo B, PS 3	Fire-hardened wall, Early McPhee Phase	A.D. 875 ±20	Good sample, oxidation at depths, good matrix
4	Pueblo A, PS 2,	Fire-hardened wall, Late McPhee Phase	A.D. 950 ±20	Fair-good sample, good oxidation and matrix
5	Pueblo A, PS 2, subfloor	Fire-hardened area just below Floor 1 Early McPhee Phase	A.D. 840 ±15	Good sample, extensive oxidation, good matrix, possibly fill (?)
6	Pueblo A, Rm 1, Floor 1, Level 2, Fea 17	Temp. hearth Late McPhee Phase	A.D. 960 ±20	Poor sample, slightly oxidized area, fair matrix, charcoal inclusion
7	Pueblo A, Rm 3, Fea 16	Temp. hearth Late McPhee Phase	A.D. 975 ±25	Good sample, some organic inclusion, fair matrix, good oxidation
8	Pueblo A, W 1/3 of Ctyd 1, Level 1, Fea 20	Hearth Late McPhee Phase	A.D. 960 ±25	Fair sample, some organic inclusion, good matrix, oxidation
9	Pueblo A, W 1/3 of Ctyd 1, Level 1, Fea 7	Hearth Late McPhee Phase	A.D. 960 ±25	Fair-good sample, charcoal inclusion, good matrix and oxidation
10	Pueblo A, Rm 10, Sur 1, Fea 14	Slab-lined hearth Middle McPhee Phase	A.D. 920 ±30	Fair-good sample, high organic inclusion, fair matrix, good oxidation

Site 5MT4475 (McPhee Pueblo) (Page 2 of 2)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
11	Pueblo A, Rm 7, Level 1, Fea 9	Slab-lined hearth Late McPhee Phase	A.D. 960 ±300	Good sample, excellent oxidation, some organic inclusion, fair-good matrix
12	Pueblo A, Rm 7, Level 1, Fea 15	Slab-lined hearth Late McPhee Phase	A.D. 960 ±30	Good sample, very little organic inclusion, excellent oxidation
13	Pueblo A, E 1/3 of Ctyd 1, Level 1, Fea 12	Slab-lined hearth Late McPhee Phase	A.D. 960 ±30	Good sample, some organic inclusion, good oxidation

REFERENCES CITED

[1] Eighmy, Jeffery L., R.S. Sternberg, and R.F. Butler 1980. Archaeomagnetic dating in the American Southwest. American Antiquity 45(3):507-517.

[2] Rodgers, J.B. 1978. Archaeomagnetic sampling: a procedural primer. Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

[3] Michels, J.W. 1973. Dating methods in archaeology. New York, Seminar Press.

[4] Watanabe, N. and R.L. DuBois 1965. Some results of an archaeomagnetic study on secular variation in the Southwest of North America. Journal of Geomagnetism and Geoelectricity 17(3-4):395-397.

[5] Weaver, K.F. 1967. Magnetic clues help date the past. National Geographic Magazine May 1967, 696-701.

[6] DuBois, R.L. 1975. Secular variation in southwestern United States as suggested by archaeomagnetic studies. In Takesi Nagata Conference Magnetic Field: Past and Present, edited by R.M. Fischer, N. Fuller, V.A. Schmidt, and P.J. Wasilewaski. Goddard Space Flight Center, Greenbelt, Maryland.

[7] Wolfman, Danice 1979. Archaeomagnetic dating in Arkansas. Archaeo-Physica 10:522-533.

[8] Irving, E. 1964. Paleomagnetism and its application to geological and geophysical problems. John Wiley and Sons. New York.

[9] Eighmy, Jeffery L. 1980. Archaemagnetism: a handbook for the archaeologist. Cultural Resource Management Series 58, U.S. Dept. of Interior, Heritage Conservation and Resources Service, Washington.

[10] Nagata, T. 1961. Rock magnetism. Marvzen Company Ltd., Tokyo.

[11] Hewitt, Nancy J. 1981. Excavations at Little House (Site 5MT2191), a Pueblo I/Pueblo II field house. In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(7). Final report submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[12] Brisbin, Joel M. 1981. Excavations at Dos Casas Hamlet (Site 5MT2193), a Basketmaker III/Pueblo I habitation site. In Field investigations: Sagehen Flats Locality, 1979. Dolores Archaeological Program Technical Reports V(5). Submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[13] Hewitt, Nancy J. 1981. Excavations at Sagehill Hamlet (Site 5MT2198), a Basketmaker III/Pueblo I habitation site. In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(5). Final report submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[14] Bussard, M. Edward 1980. Preliminary report on excavations at Marshview Hamlet (Site 5MT2235). In Field investigations: 1978. Dolores Archaeological Program Technical Report I(9). Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

[15] Brisbin, Joel M. 1980. Preliminary report on excavations at McPhee Pueblo (Site 5MT4475). In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(8). Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

APPENDIX A

SITE-BY-SITE SUMMARY OF ARCHAEOMAGNETIC SAMPLES
1978 FIELD SEASON

Site 5MT2151 (LeMoc Shelter)

Sample #	Provenience	Cultural Context	Archaeological Guess Date (A.D.)	Sample Quality and Comments
1	Sq 8E19, Str 3 Fea 26	Temp. hearth Sundial Phase	1000 ±20	Good sample, some organic inclusion, good oxidation
2	Room 10, Str 1	Fire-hardened floor, McPhee Phase	875 ±25	Good sample, good oxidized surface, but very shallow
3	Sq 8E13, Occ Area 4, Str 2, Fea 28	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Poor sample, high organic inclusion, poor matrix
4	Sq 8E11, Occ Area 3, Str 5, Fea 29	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Poor sample, high organic inclusion, poor matrix
5	Sqs 7E14, 7E15, 8E14, 8E15, Occ Area 1, Subarea 3, Fea 25	Fire-hardened cist McPhee Phase	950 ±50	Good oxidation, high organic inclusion, poor matrix
6	Sq 8E11, Occ Area 3, Str 5, Fea 29	Temp. hearth Sundial Phase or recent	1000 ±50 or 1900 ±50	Good sample, high organic inclusion
7	Sq 9E20, Str 2, Fea 24	Temp. hearth McPhee Phase	1000 ±50	Good sample, very little organic inclusion, good matrix
8	Sqs 8E21, 9E21, PS 1, Subarea 3, Str 4, Fea 38	Temp. hearth McPhee Phase	950 ±50	Good oxidation, high organic inclusion, poor matrix
9	Rm 1, Sur 1	Fire-hardened floor McPhee Phase or recent	950 ±50 1900 ±50	Good oxidation, very little organic inclusion, fair matrix
10	PS 1, Floor 1, Occ sur 1, Fea 46	Central hearth Sagehen Phase	815 ±50	Good sample, fair oxidation, excellent matrix

Site 2198 (Sagehill Hamlet)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Sqs 034032 and 036032, Level 1, Fea 2	Slab-lined hearth Sagehen Phase	A.D. 700 ±20	Good sample, moderate organic inclusion, good matrix
2	PS 1, Sur 1, Fea 8	Central hearth Sagehen Phase	A.D. 680 ±30	Very good sample, very little organic inclusion, good matrix

Site 5MT2193 (Dos Casas Hamlet)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Rm 2, Sub. 4, Sur 2, Fea 16	Temp. hearth Sagehen Phase	A.D. 775 ±25	Good sample, moderate organic inclusion, fair matrix
2	Rm 1, Sub. 4, Sur 1	Fire-hardened floor Sagehen Phase	A.D. 775 ±25	Fair sample, fair oxidation, poor matrix
3	Rm 3, Sur 2	Fire-hardened floor Sagehen Phase	A.D. 775 ±25	Very poor sample, high organic inclusion, poor matrix
4	Rm 5, Str 2, SE Quad, Fea 11	Slab-lined hearth Sagehen Phase	A.D. 775 ±25	Very good sample, some organic inclusion, good oxidation
5	Rm 1, Sur 1	Fire-hardened floor/possible roof fall Sagehen Phase	A.D. 775 ±25	Fair sample, excessive organic inclusion, good oxidation
6	Sq 120S/184E Fea 7	Hearth Sagehen Phase	A.D. 775 ±25	Good sample, some organic inclusion, good matrix

Site 5MT4457 (McPhee Pueblo) (Page 1 of 2)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
1	Pueblo A, PS 1, Sur 2, Fea 24	Central hearth Late McPhee Phase	A.D. 940 ±20	Good sample, charcoal inclusion, good oxidation
2	Pueblo A, PS 2	Fire-hardened wall, McPhee Phase	A.D. 910 ±20	Good oxidized area, but area appears disturbed, fair-poor sample
3	Pueblo B, PS 3	Fire-hardened wall, Early McPhee Phase	A.D. 875 ±20	Good sample, oxidation at depths, good matrix
4	Pueblo A, PS 2,	Fire-hardened wall, Late McPhee Phase	A.D. 950 ±20	Fair-good sample, good oxidation and matrix
5	Pueblo A, PS 2, subfloor	Fire-hardened area just below Floor 1 Early McPhee Phase	A.D. 840 ±15	Good sample, extensive oxidation, good matrix, possibly fill (?)
6	Pueblo A, Rm 1, Floor 1, Level 2, Fea 17	Temp. hearth Late McPhee Phase	A.D. 960 ±20	Poor sample, slightly oxidized area, fair matrix, charcoal inclusion
7	Pueblo A, Rm 3, Fea 16	Temp. hearth Late McPhee Phase	A.D. 975 ±25	Good sample, some organic inclusion, fair matrix, good oxidation
8	Pueblo A, W 1/3 of Ctyd 1, Level 1, Fea 20	Hearth Late McPhee Phase	A.D. 960 ±25	Fair sample, some organic inclusion, good matrix, oxidation
9	Pueblo A, W 1/3 of Ctyd 1, Level 1, Fea 7	Hearth Late McPhee Phase	A.D. 960 ±25	Fair-good sample, charcoal inclusion, good matrix and oxidation
10	Pueblo A, Rm 10, Sur 1, Fea 14	Slab-lined hearth Middle McPhee Phase	A.D. 920 ±30	Fair-good sample, high organic inclusion, fair matrix, good oxidation

Site 5MT4475 (McPhee Pueblo) (Page 2 of 2)

Sample #	Provenience	Cultural Context	Archaeological Guess Date	Sample Quality and Comments
11	Pueblo A, Rm 7, Level 1, Fea 9	Slab-lined hearth Late McPhee Phase	A.D. 960 ±300	Good sample, excellent oxidation, some organic inclusion, fair-good matrix
12	Pueblo A, Rm 7, Level 1, Fea 15	Slab-lined hearth Late McPhee Phase	A.D. 960 ±30	Good sample, very little organic inclusion, excellent oxidation
13	Pueblo A, E 1/3 of Ctyd 1, Level 1, Fea 12	Slab-lined hearth Late McPhee Phase	A.D. 960 ±30	Good sample, some organic inclusion, good oxidation

REFERENCES CITED

[1] Eighmy, Jeffery L., R.S. Sternberg, and R.F. Butler 1980. Archaeomagnetic dating in the American Southwest. American Antiquity 45(3):507-517.

[2] Rodgers, J.B. 1978. Archaeomagnetic sampling: a procedural primer. Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

[3] Michels, J.W. 1973. Dating methods in archaeology. New York, Seminar Press.

[4] Watanabe, N. and R.L. DuBois 1965. Some results of an archaeomagnetic study on secular variation in the Southwest of North America. Journal of Geomagnetism and Geoelectricity 17(3-4):395-397.

[5] Weaver, K.F. 1967. Magnetic clues help date the past. National Geographic Magazine May 1967, 696-701.

[6] DuBois, R.L. 1975. Secular variation in southwestern United States as suggested by archaeomagnetic studies. In Takesi Nagata Conference Magnetic Field: Past and Present, edited by R.M. Fischer, N. Fuller, V.A. Schmidt, and P.J. Wasilewaski. Goddard Space Flight Center, Greenbelt, Maryland.

[7] Wolfman, Danice 1979. Archaeomagnetic dating in Arkansas. Archaeo-Physica 10:522-533.

[8] Irving, E. 1964. Paleomagnetism and its application to geological and geophysical problems. John Wiley and Sons. New York.

[9] Eighmy, Jeffery L. 1980. Archaemagnetism: a handbook for the archaeologist. Cultural Resource Management Series 58, U.S. Dept. of Interior, Heritage Conservation and Resources Service, Washington.

[10] Nagata, T. 1961. Rock magnetism. Marvzen Company Ltd., Tokyo.

[11] Hewitt, Nancy J. 1981. Excavations at Little House (Site 5MT2191), a Pueblo I/Pueblo II field house. In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(7). Final report submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[12] Brisbin, Joel M. 1981. Excavations at Dos Casas Hamlet (Site 5MT2193), a Basketmaker III/Pueblo I habitation site. In Field investigations: Sagehen Flats Locality, 1979. Dolores Archaeological Program Technical Reports V(5). Submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[13] Hewitt, Nancy J. 1981. Excavations at Sagehill Hamlet (Site 5MT2198), a Basketmaker III/Pueblo I habitation site. In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(5). Final report submitted to the U.S. Bureau of Reclamation, Upper Colo. Region, Salt Lake City, in compliance with Contract No. 8-07-40-S0562.

[14] Bussard, M. Edward 1980. Preliminary report on excavations at Marshview Hamlet (Site 5MT2235). In Field investigations: 1978. Dolores Archaeological Program Technical Report I(9). Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

[15] Brisbin, Joel M. 1980. Preliminary report on excavations at McPhee Pueblo (Site 5MT4475). In Field investigations: 1978. Dolores Archaeological Program Technical Reports I(8). Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

No Change Comments

Archaeomagnetic Sampling Operations, Chapter 12, Volume I

Specific Comments

Page 1

1. Our policy has always been that a report reflects the status of the data base at the time that the report was prepared. Further, the results requested are provided in the individual report appendices and are discussed in subsequent reports on the archaeomagnetic dating program.

Page 6

2. The information requested is detailed in later reports. Given the nature and purpose of this report, the author feels that it is not appropriate to specify the type of magnetometer employed.

Page 10

2. The discussion in Michaels is not referenced as our standard for field techniques. The field techniques for recovery of samples were developed for use on the D.A.P. with reference to the archaeomagnetic field manual cited in the text.

Pages 14-22

1. See "Page 1, #1" above.

Page 21

1. The word kiva does not occur in the place indicated in the comment.

Pages 27-33

1. See "Page 1, #1" above.

RESULTS OF THE 1978 ARCHAEOMAGNETIC SAMPLING PROGRAM

Archaeomagnetic samples were collected on sites excavated during the 1978 D.A.P. field season from all fire-hardened features judged by a preliminary evaluation to be adequate for analysis. The analyses of these samples should yield information on the temporal placement, occupational span, and intra-site relationships of major structural features and of minor features within the sites recently investigated. A site-specific description of archaeomagnetic operations conducted during the 1978 field season is presented below. Appendix A contains a site-by-site summary of samples.

Site 5MT2151 (LeMoc Shelter)

Site 5MT2151 is located in a south-facing rock shelter on the north slope of the Dolores River canyon. The site is located in the Grass Mesa Archaeological Locality and probably was occupied continuously by prehistoric populations on a temporary or permanent basis for at least 400 to 500 years (A.D. 600-1050). The site is stratigraphically complex; during the earliest documented use of the shelter in the Basketmaker III and Early Pueblo I periods (approximately A.D. 600-800), the site was a small hamlet with one to two households. (The shelter might have been occupied earlier by Archaic populations; however, to date there is no evidence of any use before the Anasazi Tradition.) Later, during the Late Pueblo I and Pueblo II periods (approximately A.D. 800-1050), the site was used as a seasonal camp and processing area. Archaeomagnetic sampling at LeMoc was directed toward temporally documenting the features associated with these different use periods. A total of 10 samples was recovered from Site 5MT2151; most

features sampled during the 1978 season apparently are associated with the later Pueblo I and Pueblo II seasonal occupations.

The Archaeomagnetic Samples

Three samples were collected from hearths built on cultural fill in the western half of the shelter. The hearths are associated with Pueblo II ceramics and were probably used in the time span A.D. 950-1050; however, there is a possibiity that the hearths were also used by modern visitors in the period A.D. 1900-1950. The matrices from which the samples were removed were coarse and granular and the fires in the hearths were low-temperature in nature. Hence, these samples were taken from inferior recovery situations and are expected to have a large standard deviation.

Three samples were collected from hearths located in the fill of Pitstructure 1 in the eastern half of the shelter. These features were obviously utilized after the abandonment of the pitstructure (a Pueblo I pithouse) and are associated with Pueblo I and Pueblo II ceramics. It seems likely that the hearths date from about A.D. 850-950 (the McPhee Phase). Again, the samples were collected from questionable matrices, and a relatively large standard error is expected.

One sample was collected from the central hearth of Pitstructure 1. This structure is a fairly typical semi-rectangular Pueblo I pithouse with a fairly distinct roof-post pattern and floor-level ventilator; one tree-ring date from a roof timber indicates that the structure was built in the first half of the ninth century A.D. Therefore, it is expected that this archaeomagnetic sample will yield a date of about A.D. 825-850.

Two samples were collected from fire-hardened floor surfaces located in the roomblock to the rear (north) of the shelter. These rooms were

probably constructed during the Sagehen Phase sedentary occupation of the site (A.D. 650-850) but have probably seen much subsequent utilization. Due to the nature and extent of the burned area, one sample is thought to represent a modern fire. The other sample should allow a temporal placement of the last prehistoric use of the roomblock area, perhaps around A.D. 1050.

One sample was recovered from the bottom of a fire-hardened cist in the western half of the shelter. This feature was probably utilized during the Sundial Phase occupation, as were other features in an upper stratigraphic context in this part of the cave; a date of about A.D. 950-1050 is expected. The collecting matrix for this sample was in excellent condition, and a low sampling error is expected.

Summary

Archaeomagnetic samples recovered from LeMoc Shelter during 1978 were collected primarily from small features (hearths and cists) representing the McPhee Phase seasonal occupation of the site. Most of the sample matrices from which the collection was taken were far from ideal, and relatively large standard errors are expected. The 1978 collection from Site 5MT2151 should be adequate to sequence these many temporary occupations and to date the last period of use of Pithouse 1. In 1979, archaeomagnetic sampling operations at LeMoc will focus on determining the temporal placement and stratigraphic sequence in Pitstructure 2, a pithouse located beneath the McPhee Phase temporary-use areas in the western part of the site.

Site 5MT2191 (Little House)

Site 5MT2191 is a small surface site located in the Sagehen Flats

Locality approximately 2 km west of the Dolores River. The site probably functioned as a field house during the McPhee Phase (approximately A.D. 850-900). The site is situated 1.7 km southwest of the contemporaneous McPhee Village and might have been utilized by family groups living at this larger habitation. Architectural remains at the site consist of a small roomblock containing four jacal rooms and an activity area to the south containing several hearths and cists (for a more detailed presentation of Site 5MT2191 see Hewitt [11]). Two archaeomagnetic samples were collected from this site, one from a hearth in Room 1, the front room of the roomblock, and the other from a hearth in the activity area south of the roomblock. Both samples should temporally place the last use of both hearths, and probably the last use of the site as well. An analysis of the ceramic collection recovered from the site indicates that it was probably abandoned around A.D. 900.

Site 5MT2193 (Dos Casas Hamlet)

Site 5MT2193 is a small habitation in the Sagehen Flats area located about 3 km west of the Dolores River. This site is in the Sagehen Archaelogical Locality and functioned as a small permanent habitation or hamlet. Major architectural remains investigated at the site include a crescent-shaped roomblock of five to six south-facing jacal rooms and two pitstructures in an outside use area to the south of the roomblock. The two pitstructures are not contemporaneous; Pithouse 2 was built after Pithouse 1 had burned and is located about 10 m closer to the roomblock. Tree-ring analysis conducted on samples recovered from the pitstructures indicates that Pithouse 1 was constructed approximately A.D. 760 and Pithouse 2 approximately A.D. 770. The site was probably occupied

by a single family and can be assigned temporally to the Sagehen Phase; Site 5MT2193 was probably occupied during the time span A.D. 750-800. (For a more detailed description of Site 5MT2193, see Brisbin [12]).

During 1978, six archaeomagnetic samples were collected from the roomblock area of the site, three from hearths and three from fire-hardened floor areas. The samples will be used to temporally place the last prehistoric use of the hearths and the time of a large conflagration which apparently swept the entire roomblock; this latter was the agent responsible for the fire-hardened floor areas. It is expected that the dates for both the hearths and the floors will be in the range A.D. 780-800. Again, some of the samples collected from this site were from poor matrices, so a large standard error in these cases is anticipated.

Continued investigations at Site 5MT2193 are scheduled for the 1979 field season and include additional collection of archaeomagnetic samples. Samples will be collected from the central hearths of Pithouses 1 and 2, from burned areas on the walls of the pitstructures (both Pithouses 1 and 2 were subject to intense conflagrations during the prehistoric period), and from any additional suitable burned features (hearths, ovens, etc.) encountered during the course of the excavation.

Site 5MT2198 (Sagehill Hamlet)

Site 5MT2198 is a small hamlet located in the Sagehen Flats area 3.5 km west of the Dolores River. The site was probably occupied by a single nuclear or extended family during the Sagehen Phase. Major architectural remains investigated at the site include a pithouse and

ancillary use and storage areas to the north and east (for a more detailed discussion of Site 5MT2198, see Hewitt [13]).

Two archaeomagnetic samples were recovered from the site, one from the central hearth of the pithouse and the other from a hearth located to the southeast of this structure. The sample collected from the pithouse should temporally place the last use of this feature; tree-ring data recovered from the site indicates this placement should be in the time range A.D. 660-680. The sample from the earth to the southeast of the main house will temporally place the last prehistoric usage of this feature; the time range expected is similar to that for the sample collected from the pitstructure. A large standard error is expected with the calibration of this latter sample due to the poor quality of the collection matrix.

Site 5MT2235 (Marshview Hamlet)

Site 5MT2235 is a small surface site located in the Sagehen Flats area 1.8 km west of the Dolores River. The site is in the Sagehen Archaeological Locality, is a small permanent or seasonal habitation, and was probably occupied by one Anasazi family. The site is an anomaly in the area due to its apparent late occupation; preliminary analysis of the ceramic collection and tree-ring dates indicates that the site was occupied in the first half of the twelfth century A.D., thus placing it within the time span of the Sundial Phase. Architectural remains investigated at the site include a small pitstructure and several exterior ancillary features (for a detailed report of this site, see Bussard [14]).

Few archaeomagnetic samples were collected from the site during the 1978 field season. One sample was recovered from the central hearth of the kiva and should temporally place the last prehistoric use of this feature; the dendrochronological data indicate that the last usage was in the time span A.D. 1110-1130. The placement of the other three samples is more problematical; all were collected from hearths, two apparently located on the prehistoric ground surface (probably within outside activity areas associated with the single kiva) and the other located in post-abandonment fill layers within the kiva. This last sample obviously postdates the main occupation of the site and probably represents a seasonal use of the site area. The two surface hearths might have been utilized by the users of the kiva, by later peoples using the site area as a temporary camp, or by both. In either case, archaeomagnetic analysis of these samples should temporally place the last prehistoric usages of Site 5MT2235 at perhaps approximately A.D. 1125-1150.

Site 5MT4475 (McPhee Pueblo)

Site 5MT4475 is a large multi-component habitation possibly incorporating inter-site integrative architecture and functions. The site is located in the Sagehen Archaeological Locality and is classed as part of a larger village in the typological system developed by D.A.P. personnel; during the McPhee Phase this habitation and other large villages (Cline Crest Pueblo, House Creek Pueblo, etc.) in the Escalante Sector might have formed the first tier of a central-place-type settlement pattern. The site is situated on an alluvial terrace on the west side of the Dolores valley and is about 500 m from the river in its present course. The architectural remains at the site consist of a very large

horseshoe-shaped roomblock (probably 35 or more rooms) facing the southeast, an open area enclosed by the horseshoe containing organized outside activity areas and pitstructures, and a large trash midden to the south of the domicile area (for a description of investigations at McPhee Pueblo during 1978, see Brisbin [15]). Thirteen archaeomagnetic samples were collected from Site 5MT4475; both the roomblock area and pitstructure are represented in the collection.

The Archaeomagnetic Samples

Five samples were recovered from Pitstructures 1-3 (superimposed structures in the same horizontal location) located in the plaza area inside the horseshoe. Two of these samples were collected from Pitstructure 1 (an early Pueblo II masonry-lined kiva), one from the central hearth and the other from a burned area on the north wall. The samples should temporally place the last use and abandonment of the kiva; ceramic and stratigraphic evidence indicates this placement will be in the time span A.D. 940-970.

One sample was collected from Pitstructure 2, an early earth-lined kiva below Pitstructure 1; the sample was taken from a burned floor area in the northeast quarter of the structure. The sample should temporally place the last usage of Pitstructure 2; stratigraphic interpretation of the depositional sequence indicates this was in the time span approximately A.D. 910-940.

Two samples were recovered from matrices associated with Pitstructure 3, a Pueblo I semi-rectangular pithouse located below Pitstructures 1 and 2. One of these samples was recovered from a burned area on the south wall of the structure and the other from fallen floor-burn material behind the west wall of Pitstructure 2; this latter is asssumed to represent the

fallen roof of Pitstructure 3. These two samples should date the last usage of Pitstructure 3; stratigraphic interpretations indicate this placement will be in the time span A.D. 890-910.

Seven samples were recovered from hearths in the roomblock and courtyard area (Rooms 1, 7, 8, and 10, and Courtyard 1) in a context representing the late McPhee Phase occupation. These samples should temporally place the last usage of the roomblock; preliminary analyses of the ceramic assemblage and stratigraphic sequence at the site indicate this placement will be in the time span A.D. 940-910.

One sample was recovered from a hearth on a lower floor in Room 7; the floor apparently represents the early McPhee Phase occupation at the site. The sample should date the last occupation of these lower floors approximately A.D. 890-910, according to an interpretation of stratigraphic and ceramic evidence.

Summary

Samples collected from McPhee Pueblo during the 1978 season were recovered from rooms located in the bend of the horseshoe and from pitstructures in the interior plaza area; the samples represent the McPhee Phase occupation at the site. In general, the collecting matrices were of superior quality for recovery purposes, and relatively small standard errors are expected. Further investigations at McPhee Pueblo are planned for the 1980 field season; archaeomagnetic sampling operations during that period will be directed toward refining the tentative chronological sequence at the site and temporally placing earlier occupations.

A site-specific listing of the archaeomagnetic samples collected during the 1978 season with their proveniences and approximate dates is presented in Appendix A.

SUMMARY AND CONCLUSIONS

A total of 37 archaeomagnetic samples were collected from 6 prehistoric sites during the Dolores Archaeological Program 1978 field season; actual labor expenditures involved in the field portion of the collecting program amounted to 58 person-days. The sampling progam is expected to yield a wide range of dates, probably from A.D. 670-1150, reflecting the long sequence of occupation in the first-year study area. The range is within the current calibrated time span for archaeomagnetic dating in the American Southwest, which is from A.D. 600-1500. All Anasazi phases identified in the first-year area of operations are represented in the sample collection; however, samples representative of the Great Cut Phase (the local Archaic manifestation, approximately 5000 B.C.-A.D. 500) and the Beaver Point Phase (the local proto-historic occupation, approximately A.D. 1400-1900) are lacking, as no suitable features dating to these cultural periods were excavated during the 1978 season.

Very few mechanical or procedural problems were encountered during field operations of the program. Some scheduling difficulties did take place due to problems in assessing collecting priorities; toward the end of the season, inclement weather and damp collecting conditions also resulted in unforeseen delays. Because the field season was abruptly terminated in late November (again, due to the weather), archaeomagnetic sampling was not completed at one site, Site 5MT2193; completion of operations at this location will be given first priority during 1979.

To date, laboratory analysis of the collection has not been completed. There have been several problems with equipment and analytical

procedures at the Archaeomagnetic Dating Laboratory at Colorado State University. Presently, these problems appear to be at least partially solved. The remainder of the analyses should be completed by the start of the 1979 field season. Appendix A contains an interim report from Dr. J. Eighmy of Colorado State University.

It is anticipated that the results of the year one archaeomagnetic sampling program (when augmented by dendrochronological data) will provide a comprehensive base for evaluating the occupational sequences in the sites and localities investigated. All Anasazi cultural phases tentatively identified are well represented in the collection; a minimum of two samples was collected from all sites excavated during 1978, with one exception (the exception, Site 5MT2202, had no suitable features). The first-year collection, when calibrated with results of dendrochronological analysis and ceramic seriation, should provide excellent data for testing the validity of the accepted Master Polar Curve.

An expanded D.A.P. archaeomagnetic sampling program is scheduled for 1979, with an anticipated collection of 100 samples.

The priorities and goals of the 1979 program are as follows:

1. complete sample recovery at sites begun during the 1978 season (Site 5MT2151 and Site 5MT2193)

2. employ the sampling program to achieve fine temporal controls at two larger, stratigraphically complex sites scheduled for intensive investigation in 1979 (Grass Mesa Village, Site 5MT0023, and House Creek Village, Site 5MT2520)

3. employ the sampling program to assist in dating other, smaller sites scheduled for excavation in 1979

4. augment the sample collection to aid in testing and extending the Master Polar Curve. (The potential exists in the program area to extend the curve in the direction of the A.D. 600 limit, perhaps to A.D. 400-500).

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ABSTRACT

An archaeomagnetic sampling program was executed by Dolores Archaeological Program personnel during the 1978 field season. Currently, project investigators view archaeomagnetic analysis as a primary dating method and as an important complement to dendrochronology. During 1978, University of Colorado field crew members collected 37 archaeomagnetic samples from 6 prehistoric sites. The expected dates for the samples range from A.D. 680 to A.D. 1130; this is well within the extremes for accurate dating established for the American Southwest. Archaeomagnetic results from these samples are appendixed in the individual site reports. Approximately 45 percent of the samples provided Dolores Project archaeologists with temporal estimates of prehistoric contexts based on the samples' paleopole position relative to the current southwest virtual geomagnetic pole curve.

EDITOR'S PREFACE

This report describes the archaeomagnetic sampling program conducted during the initial season of operation of the Dolores Archaeological Program. The preparation of this report occurred before the analysis of samples was completed and the results of the analysis were included as appendixes to the individual site reports once those results became available. One concern of the Bureau of Reclamation archaeologists in reviewing this report was that the type of magnetometer used in analysis of samples was not indicated in the text. Since this report discusses only field techniques, the theoretical basis for archaeomagnetic dating, and the sites sampled during the 1978 field season, there was no place to insert information about the specific type of analytic equipment in the text. The analysis procedures and equipment are described in detail in the 1979 report on the archaeomagnetic program which states that a spinner magnetometer was used in the analysis procedure.

INTRODUCTION

Research Orientation

An archaeomagnetic sampling program was initiated for the Dolores Archaeological Program during the first year of operations. The immediate goal of the sampling program was to assemble a representative collection of archaeomagnetic dates from sites in the program area. This collection will ultimately serve two purposes. First, archaeomagnetic dating will be one of the primary methods used to assign temporal spans to occupations at prehistoric sites. In this respect, archaeomagnetic sampling is viewed as an important adjunct to the other primary dating method employed by the program, dendrochronology. These methods are often complementary, in that a cluster of tree-ring samples recovered from a prehistoric structure will frequently date the year of construction of that structure, while archaeomagnetic samples obtained from a hearth or wall in the same structure will tend to date the last utilization or abandonment. Hence, comparison of the data generated by the application of these two techniques will often allow an estimate of the duration of occupation at that structure.

The second purpose for the collection of archaeomagnetic dates is to verify the Master Polar Curve originally proposed by Dr. R.L. DuBois of Oklahoma University. Architectural and artifactual remains recovered from sites in the project area indicate perhaps a 1500-year period (from 400 B.C. to A.D. 1100) of prehistoric occupation that may be amenable to archaeomagnetic sampling. As these sites often contain structural remains with construction wood that can be dated by dendrochronological